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<p>(21) International Application Number:     PCT/US99/27851  (22) International Filing Date:            23 November 1999 (23.11.99)  (30) Priority Data:  09/216,183                  18 December 1998 (18.12.98)    US  09/290,351                  12 April 1999 (12.04.99)        US  (63) Related by Continuation (CON) or Continuation-in-Part (CIP) to Earlier Applications  US    09/216,183 (CIP)  Filed on    18 December 1998 (18.12.98)  US    09/290,351 (CIP)  Filed on    12 April 1999 (12.04.99)  (71) Applicant (<i>for all designated States except US</i>): GLAXO GROUP LIMITED [GB/GB]; Glaxo Wellcome House, Berkeley Avenue, Greenford, Middlesex UB6 0NN (GB).  (72) Inventors; and  (75) Inventors/Applicants (<i>for US only</i>): GARRILL, Karl, Andrew [GB/GB]; Glaxo Wellcome Plc, Gunnels Wood Road, Stevenage, Hertfordshire SG1 2NY (GB). HAAN, Richard, J. [US/US]; 8863 Dogwood Road, Germantown, TN 38139 (US). HERMAN, Craig, Steven [US/US]; Glaxo Wellcome Inc., Five Moore Drive, P.O. Box 13398, Research Triangle Park, NC 27709 (US). WALKER, Richard, Ian [GB/GB]; Glaxo Wellcome Plc, Gunnels Wood Road, Stevenage, Hertfordshire SG1 2NY (GB).</p>	<p>(74) Agents: LEVY, David, J.; Glaxo Wellcome Inc., Five Moore Drive, P.O. Box 13398, Research Triangle Park, NC 27709-3398 (US) et al.  (81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).</p>	
<p>(54) Title: METHOD AND PACKAGE FOR STORING A PRESSURIZED CONTAINER CONTAINING A DRUG</p>		
<p>(57) Abstract</p> <p>A method and package (22) for storing a pressurized container (34) which is filled with a drug formulation at a predetermined pressure. The drug formulation includes a mixture of a drug and a propellant. The package which encloses the pressurized container substantially prevents ingress of water vapor and particulate matter into the package while permitting egression of the propellant which may leak from the pressurized container.</p>		

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**METHOD AND PACKAGE FOR STORING  
A PRESSURIZED CONTAINER CONTAINING A DRUG**

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of U.S. Application number 09/290,351 filed April 12, 1999, which is a continuation-in-part of copending U.S. Application No. 5 09/216,183, filed on December 18, 1998, the entire contents of which are incorporated by reference.

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a method and package 10 for storing a pressurized container containing a drug.

Description of the Background Art

For environmental reasons, there has been a move to replace chlorofluorocarbons (CFCs) (also simply known as "fluorocarbons") such as P11, P114 and P12 with 15 hydrofluoroalkane propellants such as HFA-134a and HFA-227. When these hydrofluoroalkane propellants are used as a propellant in a pressurized drug delivery system, various technical problems can occur with various drug formulations. Also, it is necessary to modify the construction of metered 20 dose inhalers for optimum stability and aerosol formation.

One storing mechanism for a metered dose inhaler (MDI) uses a plastic tube which has a resealable lid to close the tube. The resealable lid for this tube employs a desiccant to absorb moisture present in the tube.

25 Such plastic tubes typically increase manufacturing cost and require complex and/or expensive manufacturing processes. Such tubes are frequently bulky in that they require a

significant amount of storage space relative to the size of the container disposed within the plastic tube.

#### SUMMARY OF THE INVENTION

Accordingly, a need in the art exists for a method and  
5 package for storing a pressurized container filled with a  
propellant and a drug which substantially prevents ingress  
of water vapor and particulate matter into the storage  
package while permitting egression of the propellant to  
increase shelf life and performance of the drug and the  
10 propellant. Furthermore, a need exists in the art to provide  
a method and package for storing a pressurized container  
filled with a drug and a propellant which is cost effective  
and which does not require complex manufacturing processes  
and which in turn efficiently envelopes the container to  
15 maximize available storage space.

It is a primary object of the present invention to  
provide a method and package for storing a pressurized  
container, where the pressurized container is filled with a  
drug and a propellant and where the method and package  
20 substantially prevent ingress of water vapor and  
particulate matter into the package while permitting  
egression of the propellant whereby shelf life of the drug is  
prolonged and performance of the drug and the propellant are  
maintained or increased.

25 It is a further object of the present invention to  
provide a method and package for storing a pressurized  
container filled with a drug and a propellant where the  
method and package substantially absorb residual moisture in  
the package enclosing the pressurized container that is  
30 sometimes present on the outer surface of the pressurized  
container prior to sealing pressurized container within the  
package.

Another object of the present invention is to provide a method and package for storing a pressurized container including a drug and a propellant which substantially reduces manufacturing costs while substantially reducing the complexity of the manufacturing process of the package.

Another object of the present invention is to provide a method and package for storing a pressurized container having a drug and a propellant which is easily opened and readily disposable.

It is a further object of the present invention to provide a method and package for storing a pressurized container having a drug and a propellant, whereby the propellant preferably meets governmental guidelines which prohibit the use of CFCs.

Another object of the present invention is to provide a method and package for storing a pressurized container which includes a drug and a propellant that does not require complex mechanical devices to envelope or enclose the pressurized container while substantially reducing the amount of storage space needed for the pressurized container where the package substantially conforms to the shape of the pressurized container. The package is amorphous in shape due to the flexible materials from which it is made.

Another object of the present invention is to provide a method and package which form an enclosed volume that stores a pressurized container in a controlled environment where the pressurized container is isolated from harmful environmental conditions such as humidity, dust, light, and water vapor and other particulate matter.

Another object of the present invention is to provide an article of manufacture comprising an integral aerosol dispensing apparatus, a drug formulation, and a flexible

package. It is further an object of the present invention to provide a drug formulation and carrier with packaging material having labeling and information relating to the composition contained therein and printed thereon. Additionally, a further object of the invention is to provide an article of manufacture having a brochure, report, notice, pamphlet, or leaflet containing product information.

These and other objects of the present invention are fulfilled by providing a container storage system comprising: a drug formulation comprising a mixture of a drug and a propellant; a pressurized container filled with the drug formulation at a predetermined pressure; and a flexible package for wrapping and sealing the pressurized container providing an enclosed volume in which the pressurized container is disposed, the flexible package being impermeable to water vapor and permeable to the propellant, the flexible package substantially preventing ingress of water vapor and particulate matter into the enclosed volume while permitting egression of the propellant.

In addition, these and other objects of the present invention are also accomplished by providing a method of storing a container comprising the steps of: providing a flexible package material, which is impermeable to water vapor and permeable to a propellant; filling a container with a drug formulation comprising a drug and the propellant at a predetermined pressure; wrapping the container with the flexible package material to form an enclosed volume in which the container is disposed therein; and sealing the flexible package which in turn closes said enclosed volume, the flexible package substantially preventing ingress of water vapor and particulate matter into the enclosed volume while

permitting egression of the propellant from the enclosed volume.

Moreover, these and other objects of the present invention are fulfilled by a packaged metered dose inhaler comprising: an MDI comprising a container and a drug metering valve, a pressurized drug formulation in the container comprising a propellant and a drug dispersed or dissolved in the propellant; and an overwrap of flexible material enclosing said MDI, the overwrap being made of a moisture impermeable or substantially moisture impermeable material.

Also, these and other objects of present invention are accomplished by providing an article of manufacture comprising: an aerosol dispensing apparatus for dispensing metered amounts of fluid material from a reservoir, the apparatus comprising a container defining a reservoir, a dispensing valve; a drug formulation located within the aerosol dispensing apparatus comprising a safe and effective medicament and a pharmaceutically acceptable propellant; and a flexible package for wrapping and sealing the container providing an enclosed volume in which said pressurized container is disposed, the flexible package being substantially impermeable to water vapor and permeable to the propellant, the flexible package substantially preventing ingress of water vapor and particulate matter into the enclosed volume while permitting egression of the propellant.

These and other objects of the present invention are also accomplished by providing a method of improving a product performance comprising the steps of: providing a flexible package material made of at least one heat sealable layer, at least one layer of a metal foil, and a protective layer; the flexible package material being impermeable to water vapor and permeable to a propellant; filling a



container with a drug formulation comprising a drug and the propellant at a predetermined pressure; wrapping the container with the flexible package material to form an enclosed volume in which the container is disposed therein; and sealing the flexible package which in turn closes the enclosed volume, the flexible package substantially preventing ingress of water vapor and particulate matter into the enclosed volume while permitting egression of the propellant from the enclosed volume.

Another embodiment of the present invention is directed to a pressurized container storage system comprising a drug formulation comprising a mixture of a drug and a propellant; a pressurized container filled with said drug formulation at a predetermined pressure; a flexible package for wrapping and sealing said pressurized container providing an enclosed volume in which said pressurized container is disposed; and a desiccant in said enclosed volume.

Further scope of applicability of the present invention will become apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will become more fully understood from the detailed description given hereinbelow and the accompanying drawings which are given by way of illustration



only, and thus are not limitative of the present invention, and wherein:

Figure 1 is a top elevational view of the package for storing a pressurized container of the present invention;

5 Figure 2 is a side view of the package for storing a pressurized container of the present invention;

Figure 3 is a cutaway bottom view of the package for storing a pressurized container of the present invention;

10 Figure 4 is a cross-sectional view of the package for storing a pressurized container of the present invention;

Figure 5 is a cross sectional view of a metering valve which could be used in the present invention; and

15 Figure 6 is a side view of the second container with a product label which is placed over the wrapping means of the present invention.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

##### Pressurized Containers

The pressurized containers useful in the invention include any containers in which a drug and a propellant can be stored. Slow leakage of propellant sometimes occurs in metered dose inhalers (MDIs) and the present invention is particularly useful in connection with MDIs that may have slow leakage.

25 The pressurized container is preferably an MDI or an MDI can. The term "metered dose inhaler" or "MDI" means a unit comprising a can, a crimped cap covering the mouth of the can, and a drug metering valve situated in the cap, while the term "MDI system" also includes a suitable channeling device. The term "MDI can" means the container without the cap and valve. The term "drug metering valve" or "MDI valve" refers to a valve and its associated mechanisms which delivers a

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predetermined amount of drug formulation from an MDI upon each activation. The channeling device may comprise, for example, an actuating device for the valve and a cylindrical or cone-like passage through which medicament may be delivered from the filled MDI can via the MDI valve to the nose or mouth of a patient, e.g. a mouthpiece actuator. The relation of the parts of a typical MDI is illustrated in U.S. Patent 5,261,538 incorporated herein by reference. An exemplary MDI is disclosed in WO 96/26755, the entire contents of which are hereby incorporated by reference. Other exemplary pressurized containers for use in MDIs are disclosed in WO 96/32151, WO 96/32345, WO 96/32150 and WO 96/32099.

The pressurized container 34 is preferably a vial made from aluminum. However, other materials are not beyond the scope of the present invention. Other materials for the pressurized container 34 include, but are not limited to, ferrous alloys, non-ferrous alloys, such as stainless steel, ceramic materials, polymers, composite materials, and mixtures thereof. Suitable containers which contain a polymeric coating on the inside thereof are disclosed in WO 96/32151.

Most often the MDI can and cap are made of aluminum or an alloy of aluminum, although other metals not affected by the drug formulation, such as stainless steel, an alloy of copper or tin plate, may be used. An MDI can may also be fabricated from glass or plastic. Preferably, however, the MDI cans employed in the present invention are made of aluminum or an alloy thereof. Advantageously, strengthened aluminum or aluminum alloy MDI cans may be employed. Such strengthened MDI cans are capable of withstanding particularly stressful coating and curing conditions, e.g.,

particularly high temperatures, which may be required for certain fluorocarbon polymers. Strengthened MDI cans which have a reduced tendency to malform under high temperatures include MDI cans comprising side walls and a base of increased thickness and MDI cans comprising a substantially  
5 ellipsoidal base (which increases the angle between the side walls and the base of the can), rather than the hemispherical base of standard MDI cans. MDI cans having an ellipsoidal base offer the further advantage of facilitating the coating  
10 process.

The MDI cans include MDI cans supplied by Presspart of Cary, North Carolina, USA or the United Kingdom, or by Neotechnic of the United Kingdom. The MDI cans typically have a neck diameter of 20 millimeters, although any suitable  
15 neck diameter may be used and can vary in height from 30 millimeters to 60 millimeters.

The drug metering valve consists of parts usually made of stainless steel, a pharmacologically inert and propellant resistant polymer, such as acetal (polyoxymethylene),  
20 polyamide (e.g., Nylon®), polycarbonate, polyester, fluorocarbon polymer (e.g., Teflon®) or a combination of these materials. Additionally, seals and "O" rings of various materials (e.g., nitrile rubbers, polyurethane, acetyl resin, fluorocarbon polymers), or other elastomeric  
25 materials are employed in and around the valve.

The preferred MDI valves have typical metering chamber volumes of 25 to 63 microlitres. The valves preferably have a ferrule skirt to suit a 20 mm neck diameter can. Typical suppliers of MDI valves include Valois Pharm, France; Bepak  
30 of Europe or the United Kingdom; or Neotechnic, United Kingdom.

Drugs

Preferred drugs (also referred to as "medicaments") and drug combinations are disclosed in WO 96/32151, WO 96/32345, WO 96/32150 and WO 96/32099, the entire contents of which are hereby incorporated by reference. These drugs include, for example, fluticasone propionate or a physiologically acceptable solvate thereof, beclomethasone dipropionate or a physiologically acceptable solvate thereof, salmeterol or a physiologically acceptable salt thereof and albuterol or a physiologically acceptable salt thereof. Medicaments may be selected from, for example, analgesics, e.g. codeine, dihydromorphine, ergotamine, fentanyl or morphine, anginal preparations, e.g. diltiazem; antiallergics, e.g. cromoglycate, ketotifen or nedocromil; antiinfectives e.g. cephalosporins, penicillins, streptomycin, sulphonamides, tetracyclines and pentamidine; antihistamines, e.g. methapyrilene; anti-inflammatories, e.g. beclomethasone (e.g. the dipropionate), flunisolide, budesonide, tipredane or triamcinolone acetonide; antitussives, e.g. noscapine; bronchodilators, e.g. salbutamol, salmeterol, ephedrine, adrenaline, fenoterol, formoterol, isoprenaline, metaproterenol, phenylephrine, phenylpropanolamine, pirbuterol, reproterol, rimiterol, terbutaline, isoetharine, tulobuterol, orciprenaline, or (-)-4-amino-3,5-dichloro- $\alpha$ -[[[6-[2-(2-pyridinyl)ethoxy]hexyl]-amino]-methyl]benzenemethanol; diuretics, e.g. amiloride; anticholinergics e.g. ipratropium, atropine or oxitropium; hormones, e.g. cortisone, hydrocortisone or prednisolone; xanthines e.g. aminophylline, choline theophyllinate, lysine theophyllinate or theophylline; and therapeutic proteins and peptides, e.g. insulin or glucagon. It will be clear to a person skilled in the art that, where appropriate, the

medicaments may be used in the form of salts (e.g. as alkali metal or amine salts or as acid addition salts) or as esters (e.g. lower alkyl esters) or as solvates (e.g. hydrates) to optimise the activity and/or stability of the medicament and/or to minimize the solubility of the medicament in the propellant.

Additionally, any suitable combination of drugs can be used in the present invention. For example, Seretide (fluticasone and Serevent) can be used in the present invention.

When the drug is present in the form of particles, the drug particles usually have a conventional particle size of less than 20  $\mu$ , preferably 0.5 to 10  $\mu$ , more preferably 1 to 5  $\mu$ . The particle size is preferably measured as a mass mean aerodynamic diameter. The drug is usually included in an amount of at least about 0.01% by weight of the composition, preferably in an amount of between 0.02 and 0.5% by weight.

**Particulate or dissolved - how to measure moisture content?**

#### Propellants

"Propellants" used herein mean pharmacologically inert liquids with boiling points from about room temperature (25°C) to about -25°C which singly or in combination exert a high vapor pressure at room temperature, including CFCs such as Freon and hydrofluorocarbons. Upon activation of the MDI system, the high vapor pressure of the propellant in the MDI forces a metered amount of drug formulation out through the metering valve then the propellant very rapidly vaporizes dispersing the drug particles. The propellants used in the present invention are low boiling fluorocarbons; in particular, hydrofluorocarbons or hydrofluoroalkanes such as HFA-134a and HFA-227. The invention is particularly useful

with propellants (including propellant mixtures) which are more hygroscopic than P11, P114 and/or P12 such as HFA-134a and HFA-227.

#### Additional Components of the Drug Formulation

5       The MDIs taught herein are particularly useful for containing and dispensing inhaled drug formulations with hydrofluoroalkane propellants such as 134a with little, or essentially no, excipient and which tend to deposit or cling to the interior walls and parts of the MDI system. In  
10 certain cases, it is advantageous to dispense an inhalation drug with essentially no excipient, e.g., where the patient may be allergic to an excipient or the drug reacts with an excipient.

Drug formulations for use in the invention may be free  
15 or substantially free of formulation excipients, e.g., surfactants and cosolvents, etc. Such drug formulations are advantageous since they may be substantially taste and odor free, less irritant and less toxic than excipient-containing formulations. Thus, a preferred drug formulation consists  
20 essentially of a drug, or a physiologically acceptable salt or solvate thereof, optionally in combination with one or more other pharmacologically active agents, and a fluorocarbon propellant.

Further drug formulations for use in the invention may  
25 be free or substantially free of surfactant. Thus, a further preferred drug formulation comprises or consists essentially of a drug (or a physiologically acceptable salt or solvate thereof), optionally in combination with one or more other pharmacologically active agents, a fluorocarbon propellant  
30 and 0.01 to 5% w/w based on the propellant of a polar cosolvent, which formulation is substantially free of

surfactant. Preferred propellants are 1,1,1,2-tetrafluoroethane, 1,1,1,2,3,3,3-heptafluoro-n-propane or mixtures thereof, and especially 1,1,1,2-tetrafluoroethane or 1,1,1,2,3,3,3-heptafluoro-n-propane. However, the drug  
5 formulation may contain any additional excipients which are necessary or desirable to prepare a suitable drug formulation.

The term "excipients" as used herein means chemical agents having little or no pharmacological activity (for the  
10 quantities used) but which enhance the drug formulation or the performance of the MDI system. For example, excipients include but are not limited to surfactants, preservatives, flavorings, antioxidants, antiaggregating agents, and cosolvents, e.g., ethanol and diethyl ether.

15 Suitable surfactants are generally known in the art, for example, those surfactants disclosed in European Patent Application No. 0327777. The amount of surfactant employed is desirably in the range of 0.0001% to 50% w/w ratio relative to the drug, in particular 0.05 to 5% w/w ratio.

20 A polar cosolvent such as C<sub>2-6</sub> aliphatic alcohols and polyols, e.g., glycerol, ethanol, isopropanol and propylene glycol, preferably ethanol, may be included in the drug formulation in the desired amount, either as the only excipient or in addition to other excipients, such as  
25 surfactants. Suitably, the drug formulation may contain 0.01 to 5% w/w based on the propellant of a polar cosolvent, e.g., ethanol, preferably 0.1 to 5% w/w, e.g., about 0.1 to 1% w/w.

#### Flexible Packaging Materials

The flexible packaging material can be any material  
30 which is impervious to or substantially impervious to moisture. The packaging material is preferably permeable to



propellants such as HFA-134a and/or HFA-227 whereby if the propellant slowly leaks from the pressurized container, the propellant will slowly pass, by diffusion or otherwise, through the packaging material.

5 For ease of manufacturing, and in order to provide the necessary properties to the packaging material, the flexible packaging material preferably comprises a non-thermoplastic substrate (such as a metal foil) and a heat sealable layer disposed thereon, and an additional protective layer, such as  
10 a polymer film of polyester. The heat sealable layer is usually disposed on the inner surface of the assembled package. The additional protective layer is usually disposed on the surface opposite the heat sealable layer. An example of a particularly useful foil laminate is a polyester film  
15 adhesively laminated to aluminum foil adhesively laminated to Ionomer (SURLYN™) film, for example, 12μ polyester/9μ aluminum/50μ ionomer film supplied by Lawson Mardon Singen (LMS).

The substrate is preferably formed from aluminum foil.  
20 However, other metals for the substrate include, but are not limited to, tin, iron, zinc, or magnesium formed on a sheet by vacuum deposition or sputtering and a carboxyl group-containing polyolefin layer formed on the metal layer by lamination.

25 The heat sealable layer can be formed from any thermoplastic or thermosetting material such as an ionomer resin, polyolefin, or cycloolefin copolymer. Ionomer resins typically include ionically crosslinked ethylene-methacrylic acid and ethylene acrylic acid copolymers. Properties which  
30 distinguish these ionomers resins from other polyolefin heat-sealed polymers are high clarity, high impact resistance, low haze in lamination, tear resistance, abrasion resistance,

solid state toughness, and moisture imperviousness. In the preferred embodiment, the heat sealable layer is made out of SURLYN™ (an ionomer resin) or a form of polyethylene to provide sufficient heat sealing properties.

5       The outer protective layer, if present, can be formed of any material as long as the final laminate has the requisite properties.

          Preferably, the protective layer (e.g., polyester) is adhesively laminated to the substrate (e.g., aluminum) and  
10   the substrate layer in turn is adhesively laminated to the heat sealable layer (e.g., the ionomer film or SURLYN™ (an ionomer resin)).

          Preferred exemplary thicknesses of the three layers include a protective layer 1 to 40, preferably 4 to 30, more  
15   preferably 10 to 23 microns, and most preferably 12 microns; a substrate layer of 1 to 100, preferably 3 to 70, more preferably 5 to 50 microns, more preferably 6 to 20 microns, and most preferably 9 microns. For the heat sealable layer, preferred exemplary thicknesses include thicknesses of 1 to  
20   100, preferably 5 to 70, more preferably 10 to 60, more preferably 20 to 55 microns, and most preferably 50 microns.

          Adhesives may be used to join the respective layers of materials together. The adhesive layers are typically substantially smaller in thickness relative to the thickness  
25   of the substrate, heat sealable and/or protective layers which they bond.

          The number, size, and shape of the layers are not limited to those layers shown in the drawings. Any number of layers with relative areas of any size and predetermined  
30   thicknesses may be used so long as the flexible package forms an enclosed volume which substantially prevents ingress of water vapor and particulate matter into the enclosed volume

while permitting egression out of the enclosed volume of any propellant leaving the pressurized container. The size, shape, and number of layers of the package is typically a function of the size and contents of the pressurized container which includes a drug and a propellant.

The package is believed to operate similarly to a virtual one-way valve due to the composition of the layers and due to the transmission rate of water vapor molecules into the enclosed volume relative to the transmission rate of gas molecules of a propellant, such as a hydrofluoroalkane, out of the enclosed volume. Small amounts of water vapor that might ingress into the enclosed volume from the environment outside the flexible package will be absorbed by the moisture absorbing materials, if present. The package permits the propellant in the pressurized container to diffuse out of the enclosed volume while substantially preventing water vapor and other particulate matter from entering the enclosed volume. Excess or leakage of the propellant is permitted to egress from the package. The virtual one-way valve function of the package prevents or minimizes the chance of any sudden ruptures or prevents or minimizes unexpected expulsion of the propellant during opening of the package.

#### Moisture Absorbing Materials

The moisture absorbing material is preferably a silica gel desiccant sachet. However, other vapor or moisture absorbing mechanisms are not beyond the scope of the present invention. Other vapor or moisture absorbing materials include desiccants made from inorganic materials such as zeolites and aluminas. Such inorganic materials of vapor or moisture absorbing materials have high water absorption

capacities and favorable water absorption isotherm shapes. The water absorption capacity of such materials typically varies from 20 to 50 weight percent.

In the preferred embodiment, the absorbing material is a  
5 MINIPAX<sup>®</sup> supplied by Multisorb Technologies in the United States and Silgelac in Europe (silica gel packaged inside TYVEK<sup>®</sup>, which is a nylon mesh bonded with a microporous polyurethane). Other exemplary moisture absorbing materials include, but are not limited to, alumina, bauxite, anhydrous,  
10 calcium sulfate, water-absorbing clay, activated bentonite clay, a molecular sieve, or other like materials which optionally include a moisture sensitive color indicator such as cobalt chloride to indicate when the desiccant is no longer operable. While in the preferred embodiment of the  
15 present invention, the package is designed to substantially prevent ingress of water vapor and particulate matter into the enclosed volume, the moisture absorbing material is placed within the enclosed volume in order to absorb any residual moisture present in the atmosphere or on the  
20 external surface of the pressurized container or mouthpiece or a combination thereof, prior to sealing the package.

The desiccant should be present in an amount sufficient to absorb any residual moisture inside the package or which might escape from inside the pressurized container. When  
25 silica gel is used, 1g to 10g of silica gel is sufficient for a typical MDI. Moreover, the desiccant should be present in an amount sufficient to absorb any moisture that possibly ingresses from the external environment.

It is also possible to place the desiccant inside the  
30 container, either loose in the canister or as part of an assembly attached to the canister.

The Container Storage System

Referring in detail to the drawings and with particular reference to Figure 1, a container storage system (or packaged product) 20 is shown. The container storage system 5 20 includes a package or wrapping 22 that employs multi-layers of material 24, 26, 28. (See Figure 4.) The package 22 further includes fin seams 30, 32 which are disposed along two parallel side edges of the package and along a single longitudinal edge of the package 22.

10 The number and type of fin seams 30, 32 are not limited to the types shown in the drawings. The package 22 can include additional seams or significantly fewer seams such as a continuous single seam. The orientation of the seams 30, 32 is not limited to the orientation shown in the drawings. 15 The orientation of the seams 30, 32 is typically a function of the sealing device and such seams may be oriented in a manner which substantially increases manufacturing efficiency. During manufacture, the longitudinal seam 30 may be formed first by heat sealing and the two end seams 32 may 20 then be formed by heat sealing to close the package. Other types of seams include, but are not limited to, gusset type seams which include excess material which provides expansibility, stitched type seams, or mechanically crimped seams, and other like structures.

25 The container storage system includes a pressurized container 34 which is preferably part of an MDI 36 (see Figure 3). While the preferred pressurized container 34 is part of an MDI 36, other devices which include pressurized containers 34 are not beyond the scope of the present 30 invention.

The fin seams 30 and 32 are formed by a conventional heat sealing device which mechanically crimps sides of the

package 22 together while simultaneously providing heat to the sides 30, 32. The heat sealing device typically has electrical heater elements shaped to produce the pattern of the fin seams 30, 32 where the fin seams include multiple  
5 ridges 38. The sealing mechanism of the container storage system 20 of the present invention is not limited to heat sealing devices. Other sealing devices include, but are not limited to, glue sealing machines, sonic welding machines, electron beam radiation machines, and other like sealing  
10 devices.

As seen in Figures 1 and 2, the package 22 preferably has a substantially rectangular configuration with a substantially elliptical cross section, however, other shapes of the package 22 are not beyond the scope of the present  
15 invention. Other shapes include, but are not limited to circular, square, triangular, trapezoidal, pentagonal, hexagonal, octagonal, and other like shapes. The shape of the package 22 is preferably a function of the shape of the enclosed pressurized container 34 as well as the amount and  
20 type of storage space since the package 22 is made from flexible materials as will be described in further detail below.

As seen in Figure 3, the package 22 provides an enclosed volume 40 in which the pressurized container 34 is disposed  
25 therein. The size of the enclosed volume 40 can be adjusted according to the size of the pressurized container 34 and related parts thereto. Preferably, the enclosed volume 40 is of a size which permits relative ease of closing respective sides and layers 24, 26 and 28 without substantial stretching  
30 of the package 22. The enclosed volume 40 may be substantially evacuated prior to formation of the fin seams 30, 32 to substantially reduce any water vapor being present



in the enclosed volume 40. The enclosed volume 40 may be evacuated to such a degree that the enclosed volume 40 is a vacuum region around the pressurized container 34. While the enclosed volume 40, may remain constant, its relative shape may change according to shifting of the pressurized container 34 disposed within the enclosed volume 40.

The amorphous shape of the enclosed volume 40 is attributed to the flexible materials which make up the layers 24, 26, 28 of the package 22 which will be discussed in further detail below. The enclosed volume can be varied in size such that it substantially conforms to the shape of the pressurized container 34 and any related parts thereto or such that the enclosed volume 40 is larger than the pressurized container 34, as shown in Figure 3. When the enclosed volume is of a size which is substantially equivalent with the surface area of the pressurized container 34 and related parts, the layers 24, 26, and 28 of material substantially conform to the shape of the pressurized canister 34 and related parts. The package is preferably placed in a separate, more rigid container, such as a paperboard or cardboard box 74 (See Figure 6) typically used in the pharmaceutical industry. The package may expand during storage due to slow leakage of the propellant from the pressurized container. In this situation, the shape of the package may conform to some extent to the internal shape of the rigid container if the volume of the rigid container is just slightly larger than the expanded volume of the flexible package.

In one exemplary embodiment, Figure 3 shows the pressurized container 34 to be connected to a nozzle 42 by a valve stem 44. The pressurized container 34 is preferably an aluminum metal vial having a metering valve 60 (See Figure 5)



disposed therein which is connected to the valve stem 44. The pressurized container 34 is not limited to the nozzle 42 and valve stem 44 shown and the metering valve 60. While the pressurized container 34 preferably includes a metering valve, other valve systems are not beyond the scope of the present invention. Other valve systems include, but are not limited to, wedge gate valve systems, double-disc gate valve systems, globe and angle valve systems, swing check valve systems, end cock valve systems, and other like valve systems. Since the pressurized container 34 is preferably part of an MDI, the valve design is typically a function of providing a predetermined dosage or amount of the drug contained within the pressurized container 34 to a user.

The nozzle 42 is typically fixably secured to the mouthpiece 46. However, other embodiments where the nozzle 42 is separate or detached from the mouthpiece 46 is not beyond the scope of the present invention. The pressurized canister 34, the nozzle 42, and the mouthpiece 46 together comprise an MDI 36.

As seen in Figure 3, nozzle 42 is in fluid communication with the mouthpiece 46 so that upon movement of the pressurized container relative to the mouthpiece 46 in a direction where the pressurized container 34 moves towards the nozzle 42 fixed to one side of the mouthpiece 46, a metered dosage or predetermined amount of the drug and propellant contained within the pressurized container 34 is released. Such a combination of the fixed nozzle 42, mouthpiece 46, valve stem 44, and pressurized container 34 form an MDI 36 as outlined above.

The MDI 36 can be packaged by the flexible packaging material 22 in either an assembled state (valve stem 44 fixed to nozzle 42) or a disassembled state (valve stem 44 detached

from nozzle 42). In a preferred embodiment, the moisture absorbing material 50 lays adjacent to the mouthpiece 46 in a loose or free flowing manner. Alternatively, the moisture absorbing material can be secured to the inside of the flexible package. In another alternative embodiment, the moisture absorbing material may be disposed within the container 34 or attached to a bracket structure such as a ring which is fastened to the container 34.

In one possible embodiment, the moisture absorbing material may be attached to the external surface of the mouthpiece 46 by a fastening device such as a rubber band 48. The fastening device 48 is preferably a removable elastic mechanism such as a rubber band. However, other fastening devices are not beyond the scope of the present invention. Other fastening devices include, but are not limited to, adhesives, adhesive tapes, shrink-wrap plastic, fasteners such as screws, nails, or rivets, compartments which are part of the mouthpiece housing 46, and other like attachment devices.

The mouthpiece 46 substantially encloses pressurized container 34. The mouthpiece 46 is preferably simple in structure so that manufacturing efficiency and economy is substantially increased. However, other mouthpieces 46 are not beyond the scope of the present invention. Other mouthpieces include, but are not limited to, relatively movable mouthpieces with multiple parts, mouthpieces which also include a protective casing substantially surrounding the mouthpiece protecting the mouthpiece 46 from damage due to shock, and other like mouthpiece structures.

The pressurized container 34 may be held in the mouthpiece 46 by ribs or projections (not shown) extending from walls of the mouthpiece so that the pressurized

container 34 is in a press-fit engagement with the mouthpiece 46. The valve stem 44 also provides a secure connection to the nozzle 42 which is fixedly secured to the mouthpiece 46. Other types of supporting mechanisms which hold the pressurized container 34 within the mouthpiece 46 are not beyond the scope of the present invention. Other types of securing or supporting mechanisms include, but are not limited to, fasteners such as screws, nails, or rivets, adhesives, mouthpieces with a female or male locking/keying mechanism which engages with a predetermined shape of the pressurized container, or other like supporting structures.

In the preferred embodiment of the invention, the support mechanisms, such as ribs or projections (not shown) of the mouthpiece 46 are designed for manufacturing efficiency which in turn reduces cost of the overall manufacturing process of the mouthpiece 46. The mouthpiece 46 is preferably made of plastic, however other materials are not beyond the scope of the present invention. Other materials for the mouthpiece 46 include, but are not limited to, ferrous alloys, non-ferrous alloys, ceramic materials, and composite materials and any mixtures thereof. Similar to the mouthpiece, the valve stem 44 is preferably made of plastic, but other materials are not beyond the scope of the present invention. Other materials for the valve stem 44 include, but are not limited to, ferrous alloys, non-ferrous alloys, ceramic materials, composite materials, and any mixtures thereof.

The pressurized container 34 preferably includes a liquid stored within the pressurized container 34 at a predetermined pressure. The liquid preferably includes a drug dispersed or dissolved therein such as salmeterol or fluticasone propionate.

In Figure 4, a cross-sectional view of the package 22 is shown. Fin seams 32 include two peripheral edges 52, 54 of the flexible packaging material. The flexible packaging material comprises a first layer 24, a second layer 26, and a third, preferably heat sealable, layer 28 of material. The first layer 24 and third layer 28 are preferably made from polymers. The first layer 24 is preferably made out of polyester while the third layer 28 is preferably made out of an ionomer resin. The second layer 26 is preferably made of a metal foil. In the preferred embodiment, the metal foil is made out of aluminum. In an alternative embodiment, the heat sealable layer is a polyethylene film.

As stated above, preferably, the protective layer (e.g., polyester) is adhesively laminated to the substrate (e.g., aluminum) and the substrate layer in turn is adhesively laminated to the heat sealable layer (e.g., the ionomer film or SURLYN™ (an ionomer resin) or a polyethylene film).

Preferred exemplary thicknesses of the three layers include a protective layer made of a polyester film having a thickness of 1 to 40, preferably 4 to 30, more preferably 10 to 23 microns, and most preferably 12 microns; a substrate layer made of aluminum having a thickness of 1 to 100, preferably 3 to 70, more preferably 5 to 50 microns, more preferably 6 to 20 microns, and most preferably 9 microns. For the heat sealable layer, an ionomer film is used having a preferred exemplary thicknesses of 1 to 100, preferably 5 to 70, more preferably 10-60, more preferably 25-55 microns, and most preferably 50 microns. In an alternative embodiment, a heat sealable layer of polyethylene film is used having a preferred thicknesses of 1 to 100, preferably 5 to 70, more preferably 10-60, more preferably 20-50 microns, and most preferably 50 microns.

Preferred exemplary embodiments include a polyester film as the protective layer having a thickness ranging from 12 to 23 microns. The polyester film is laminated to an aluminum foil as the substrate layer having a thickness ranging from 6 to 20 microns. The aluminum foil is laminated to a sealing film such as either an inomer film having a thickness ranging from 25 to 50 microns or a polyethylene film having a thickness ranging from 20 to 50 microns.

Alternative preferred embodiments include aluminum metalized polyester film laminated to a heat sealable layer as outlined above. Another embodiment includes a silicon oxide coplated polyester film laminated to a heat sealable layer as outlined above. Yet, in another embodiment, a polyester film as a protective layer having a thickness ranging from 12 to 30 microns is laminated to an aluminum foil substrate layer having a thickness ranging from 6 to 20 microns, the aluminum foil being laminated to a polyester film of 12 to 30 microns which is laminated to a heat sealable layer as outlined above. In another embodiment, a polypropylene film as a protective layer having a thickness ranging from 15 to 30 microns is laminated to an aluminum foil substrate layer having a thickness ranging from 6 to 20 microns, and the aluminum foil is laminated to a heat sealable layer as outlined above. The laminates of the present invention can be adhesively laminated or extrusion laminated.

The general structure for the preferred embodiment of the present invention is as follows: OUTSIDE ENVIRONMENT, POLYESTER FILM 24, ALUMINUM FOIL 26, IONOMER FILM 28, ENCLOSED VOLUME 40, IONOMER FILM 28, ALUMINUM FOIL 26, POLYESTER FILM 24, OUTSIDE ENVIRONMENT. (See Figure 4.)

The lines in the drawings which show the boundaries between respective layers 24, 26, and 28 may be considered as adhesive layers if adhesives are used to join the respective layers. In other words, for example, the line separating  
5 protective layer 24 from the metal foil layer 26 may be interpreted as an adhesive, if an adhesive is used to join these layers 24, 26.

Figure 5 shows an exemplary fluid dispensing apparatus 36 containing a metered aerosol dispensing valve 60 which  
10 dispenses metered amounts of fluid material 76 from a reservoir 64. The fluid dispensing apparatus (or metered dose inhaler) may also be packaged as an article of manufacture (shown in Figures 2, 3, or 6) comprising an aerosol dispensing valve 60 of the present invention, an  
15 integral or additional dispensing apparatus, and a safe and therapeutically effective amount of a medicament in a pharmaceutically acceptable carrier, particularly a propellant. The medicament and carrier can also contain other medications and various excipients.

20 The packaging material of the article of manufacture may also have labeling 55 and information relating to the composition contained therein and/or printed thereon, such as by an adhesive label secured to the exterior of the flexible package. Additionally or alternatively, the article of  
25 manufacture of the present invention may have a brochure, report, notice, pamphlet, or leaflet 65 containing product information. This form of product information is sometimes, in the pharmaceutical industry, called the "package insert." A package insert 65 may be attached to or included with the  
30 article of manufacture. The package insert will usually be provided inside the box 74 but outside the flexible package. The package insert 65 and any article of manufacture labeling



provides information relating to the composition and use of the product. This information and labeling provides various forms of information utilized by health care professionals and patients that describes the composition, the dosage, the use, and various other parameters of the medicament required by regulatory agencies, such as the United States Food and Drug Administration.

Figures 5 and 6 show an article of manufacture including packaging material 22, a fluid dispensing apparatus or MDI 34 for dispensing metered amounts of fluid material 76 from a reservoir 64. In one exemplary embodiment, the fluid dispensing apparatus 34 can include a container 34 defining a reservoir 64, and a dispensing valve 60. The dispensing valve 60 can include a metering chamber body 62, defining a metering chamber 66 and having one or more metering chamber ports 68; and a stem 42 allowing for slideable movement within the metering chamber body 62. The stem 42 has a dispensing passage 70 and is connected to a sealing segment 72 allowing for slideable movement over the one or more metering chamber ports 68. The present invention is not limited to the fluid dispensing apparatus shown in Figure 5 and can include other types of fluid dispensing devices.

The stem 42 and sealing segment 72 can be moveable such that in a first position the metering chamber 66 is fluidically isolated from the dispensing passage 70, and the metering chamber 66 is in fluidic communication with the reservoir 64 through the one or more metering chamber ports 68 and the dispensing passage 70. In a second position (as shown in Figure 5), the metering chamber 66 is in fluidic communication with the dispensing passage 70; and the metering chamber 66 is fluidically isolated from the reservoir 64 by the sealing segment 72 occluding the one or



more metering chamber ports 68 and the stem occluding the dispensing passage 70. Also shown in Figure 5, is fluid material 76 containing a safe and effective medicament and a pharmaceutically acceptable carrier or diluent or propellant.

5       The dispensing valve 60 can further include an upper sealing sleeve 78 and lower sealing sleeves 80 and 80'. Stem 42 is positioned for slideable movement within metering chamber 7 through the lower and upper aperture containing lower sealing sleeves 80 and 80' and the upper sealing sleeve  
10 78.

Flange 82 and spring 84 define the limits of travel for stem 42. Within these limits of travel, the stem 42 occupies an infinite number of positions which include the above mentioned first and second positions. In Figure 5, stem 42  
15 is biased toward the upper sealing sleeve 78 in the second position by physical force exerted by a user.

In Figure 6, a box 74 encloses the container storage system 20. On the exterior of the box 74, a label 55 is disposed which provides information relating to the  
20 composition contained within the MDI. The label 55 may be located on any side of the box 74, that is most beneficial to the user. Further, as mentioned above, a package insert 65 may be disposed within the box 74 and outside the container storage system 20.

25       The present invention also provides a method of storing a container 34 including the steps of providing a flexible package 22 where the package 22 includes layers 24, 26, and 28 of material which are collectively impermeable to water vapor and permeable to vaporized propellant.

30       The method includes the step of filling the container 34 with the liquid propellant at a predetermined pressure and wrapping the container 34 with the flexible package 22 to

form an enclosed volume 40 in which the first container 40 is disposed therein.

The method further includes sealing the flexible package 22 which in turn closes the enclosed volume 40, so that the flexible package 22 substantially prevents ingress of water vapor and particulate matter into said enclosed volume 40 while permitting egression of said vaporized propellant, whereby shelf life and performance of the drug and the propellant are increased. The packaged product can be stored for prolonged periods of time such as 1 month or more, 3 months or more or 6 months or more at temperatures such as 25, 30 or 40°C and at relative humidities of 60 or 75% while maintaining acceptable product properties.

The invention further includes method steps drawn to providing a material 50 for absorbing moisture in the enclosed volume 40 and disposed adjacent to the container 34.

#### Examples and Comparative Tests/Analysis

In order to evaluate the effectiveness of the method and package for storing a pressurized canister of the present invention, shelf-life tests were carried out upon packages 22 which contained MDIs such as salmeterol/HFA-134a inhalers, Albuterol/HFA-134a, and Fluticasone Propionate/HFA-134a inhalers. The drug was present in the formulation in the form of particles. No additional excipients or additives were present in the invention. A first shelf-life test of Albuterol/HFA-134a inhalers showed that by placing an MDI into the package 22 containing silica gel desiccant or an absorbing mechanism 50, it was possible to substantially reduce the amount of moisture ingress (measured in Parts Per Million or PPM) into the inhaler after three months of storage at 40°C and at 85% relative humidity. See Table 1.

**Table 1**

Sample	Initial	1 month @40°C/85%RH	3 months @40°C/85%RH
Control (non overwrapped inhaler)	35ppm	330ppm	446ppm
Inhaler sealed in foil overwrap with 10g silica gel desiccant	35ppm	106ppm	178ppm
Inhaler stored in Zantac Efferdose tube	35ppm	158ppm	198ppm

Also included in Table 1 is data for MDIs which are stored in the prior art type tube containers. The prior art type tubes included a ZANTAC™ EFFERDOSE™ tube. This type of tube is a plastic tube which contains silica gel desiccant. The silica gel is disposed in a resealable lid that closes the tube. This tube construction is similar to that used for a Schering product, VANCERIL™ double strength.

A second test was performed and the results indicate that the reduction of moisture content within the package can improve overall product performance of the liquid contained within the pressurized container 34, where the liquid includes an asthma treating drug and a propellant. In the second test, the experiment was performed where aged non-overwrapped salmeterol/HFA-134a inhalers were compared to MDIs provided in the package 22. The experiment included non-overwrapped inhalers which were stored for three months at either 30°C/60% relative humidity or 40°C/75% relative humidity. The non-overwrapped inhalers were then placed in a desiccator containing phosphorous pentoxide. The non-overwrapped inhalers were then tested for moisture content and fine particulate mass (FPM - the moisture sensitive product performance test over the period of inhaler storage). The results of this test are presented in Table 2. **Include measurement for FPM and moisture here.**

**Table 2**

Time	30°C/60%RH		40°C/75%	
	Moisture content, PPM	FPM, Mcg	Moisture content, PPM	FPM, Mcg
Initial	92	10.3	92	10.3
1 month non overwrapped	Not tested	Not tested	412	8.2
3 month non overwrapped	463	7.9	616	6.2
6 weeks storage	233	8.9	298	7.4
13 weeks storage	151	9.4	230	8.0

The data in Table 2 shows that loss and product performance (loss in FPM, for salmeterol) is directly related to change in moisture content. The results indicated that product performance of MDIs is reversible, although not 100% reversible. Therefore, if moisture causes loss in product performance, it is possible to retrieve and improve the product performance by removing moisture from the MDI during storage. Such is the result with the package 22 of the present invention. Thus, the data shows how product performance is improved by controlling the moisture content within the MDI with the present invention.

A third comparative stability test at various elevated storage conditions was performed on a batch of Salmeterol/HFA134a Inhalers that were overwrapped shortly after manufacture and compared against a control of new-overwrapped inhalers from the same batch. The FPM and moisture determinations are summarized in Table 3 and 4. Table 3 shows the FPM over six months for the control group non-overwrapped MDIs compared to overwrapped MDIs (contained within the package 22 of the present invention). Table 4 shows the inhaler moisture content in Parts Per Million (or PPM) over six months for the control group of non-overwrapped

meter dose inhalers compared to MDIs provided in the package 22 of the present invention.

The data in Table 3 shows that the fine particulate mass (FPM), measured in micrograms ( $\mu\text{g}$ ), of the MDIs provided in the package 22 of the present invention decreases at a substantially slower rate than that of the control group of non-overwrapped meter dose inhalers. The data in Table 4 shows that the moisture content in Parts Per Million (PPM) over six months for the MDI provided in the package 22 of the present invention is less than the moisture content present adjacent to or within the MDIs which are not provided with any overwrap.

**Table 3 – Fine Particulate Mass (in  $\mu\text{g}$ )**

Time point (months)	40°C/75%RH		25°C/60%RH		25°C/75%RH	
	Control	Wrapped	Control	Wrapped	Control	Wrapped
0	9.4	9.4	9.4	9.4	9.4	9.4
1	7.8	8.6	8.4	8.6	8.4	8.7
3	6.0	7.4	8.3	8.5	8.0	8.3
6	6.2	7.7	7.5	7.8	7.2	7.8

**Table 4 – Moisture Content (in ppm)**

Time point (months)	40°C/75%RH		25°C/60%RH		25°C/75%RH	
	Control	Wrapped	Control	Wrapped	Control	Wrapped
0	81	81	81	81	81	81
1	360	63	194	71	217	93
3	540	29	405	45	434	64
6	526	93	446	76	485	47

A fourth comparative test was performed on a control group of non-overwrapped MDIs containing fluticasone propionate/HFA-134a compared to MDIs of the same drug and

propellant provided in the package 22 of the present invention. The MDIs of the present invention were manufactured and provided in the package 22 of the present invention shortly after the time of manufacture and placed on  
5 stability at various elevated storage conditions along side the control group of unwrapped inhalers from the same batch.

Table 5 of the fourth test summarizes the variation in the content uniformity at the six-month time period in addition to the moisture of the control group and the MDIs  
10 provided in the package 22 of the present invention. Table 5 shows the variation in content uniformity in percentage of the relative standard deviation (RSD) based on the values for a dose ex actuator obtained from ten cans at the end of use (final nominal use). This variation test was obtained over  
15 six months for the control group of non-overwrapped MDIs compared with MDIs provided in the package 22 of the present invention.

Table 6 shows the inhaler moisture content in Parts Per Million or PPM over six months for the control group of non-  
20 overwrapped MDIs of the fluticasone propionate/HFA-134a type compared to MDIs of the same drug and propellant provided in the package 22 of the present invention. Table 5 demonstrates that the MDIs provided in the package 22 of the present invention have a substantially smaller standard  
25 deviation in product performance so that the MDI will typically have a consistent increased performance relative to non-overwrapped MDIs.

Table 6 further shows that the initial moisture content in parts per million for the MDIs 36 provided in the package  
30 22 of the present invention significantly and substantially decreases while the moisture content of the control group of

non-overwrapped MDIs substantially increases from the initial measurement of the moisture content.

**Table 5**

Time point (months)	40°C/75%RH		30°C/75%RH	
	Control	Wrapped	Control	Wrapped
0	6	6	6	6
3	14	5	11	5
4			12	5
6			12	9

\* RSD (%) = percentage relative standard deviation based on the values for dose ex actuator  
5 obtained from 10 cans at the end of use (final nominal dose).

**Table 6**

Time point (months)	40°C/75%RH		30°C/75%RH	
	Control	Wrapped	Control	Wrapped
0	198	198	198	198
3	751	50	412	61
4			408	83
6			521	30

Table 7 shows the loss of HFA-134a (in grams) for wrapped Albuterol 134a MDI's stored for 14 months at 30°C/60%RH and 40°C/75%RH. The data in Table 7 is a mean of  
10 5 determinations from 3 separate batches of MDI's.

**Table 7**

	40°C/75%RH	30°C/60%RH
Loss of HFA134a from the can (g)	0.4	0.7
HFA134a remaining in the pack (g)	0.1	0.2



The results of the above mentioned tests, outlined by Tables 1-4, prove that loss in fine particulate mass (FPM) of MDIs is directly related to moisture content adjacent or within an MDI. The results tabulated in Tables 5-7 prove  
5 that variation of the content uniformity at the end life of the wrapped MDIs of the present invention is substantially less than non-wrapped MDIs. Therefore, substantial increases in product performance of MDIs 36 are possible with the package 22 of the present invention which substantially  
10 reduces or eliminates the ingress of moisture or water vapor into the enclosed volume 40. Table 7 shows proof of the operation of the virtual one way valve mechanism that permits egression of HFA-134a from package 22.

The invention being thus described, it will be obvious  
15 that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

## WHAT IS CLAIMED IS:

1. A pressurized container storage system, comprising:  
a drug formulation comprising a mixture of a drug and a propellant;  
a pressurized container filled with said drug  
5 formulation at a predetermined pressure; and  
a flexible package for wrapping and sealing said pressurized container providing an enclosed volume in which said pressurized container is disposed, said flexible package being impermeable to water vapor and permeable to said  
10 propellant, said flexible package substantially preventing ingress of water vapor and particulate matter into said enclosed volume while permitting egression of said propellant.
2. The pressurized container storage system of claim 1, further comprising means for absorbing moisture in said enclosed volume.
3. The pressurized container storage system of claim 2, wherein said means for absorbing moisture in said enclosed volume includes a desiccant.
4. The pressurized container storage system of claim 3, wherein said desiccant includes at least one of zeolite, alumina, and silica gel.
5. The pressurized container storage system of claim 1, wherein said flexible package includes at least one heat sealable layer and at least one layer of a metal foil.

6. The pressurized container storage system of claim 5, wherein said metal foil includes at least one of aluminum, tin, iron, zinc, and magnesium.

7. The pressurized container storage system of claim 5, wherein said flexible package further includes a protective layer located on the outside of said package.

8. The pressurized container storage system of claim 7, wherein said protective layer includes a polyester film and said heat sealable layer includes an ionomer film.

9. The pressurized container storage system of claim 1, wherein said propellant includes a hydrofluroalkane.

10. The pressurized container storage system of claim 9, wherein said hydrofluroalkane is at least one of 1,1,1,2-tetrafluorethane and 1,1,1,2,3,3,3-heptafluoropropane.

11. The pressurized container storage system of claim 1, further comprising:

a nozzle attached to said container, wherein said container and said nozzle form an MDI.

12. A method of storing a container comprising the steps of:

providing a flexible package material, which is impermeable to water vapor and permeable to a propellant;

5 filling a container with a drug formulation comprising a drug and said propellant at a predetermined pressure;

wrapping said container with said flexible package material to form an enclosed volume in which said container is disposed therein; and

- 10        sealing said flexible package which in turn closes said enclosed volume, said flexible package substantially preventing ingress of water vapor and particulate matter into said enclosed volume while permitting egression of said propellant from said enclosed volume.

13. The method of storing a pressurized container of claim 12, further comprising the step of providing a moisture absorbing material in said enclosed volume.

14. The method of storing a container of claim 12, wherein said sealing step includes heat sealing said flexible package material.

15. The method of storing a container of claim 12, further comprising the steps of:

- providing a nozzle;  
providing a valve;  
5        attaching said valve to said container;  
attaching said nozzle to said valve; and  
said container, nozzle and valve forming an MDI.

16. A packaged container, comprising:

- a container containing a pressurized drug formulation in said container comprising a propellant and a drug dispersed or dissolved in said propellant;  
5        and

an overwrap of flexible material enclosing said container, said overwrap being made of a moisture

impermeable or substantially moisture impermeable material.

17. A packaged MDI, comprising:

an MDI comprising a container and a drug metering valve,  
a pressurized drug formulation in said container comprising a  
propellant and a drug dispersed or dissolved in said  
5 propellant; and

an overwrap of flexible material enclosing said MDI,  
said overwrap being made of a moisture impermeable or  
substantially moisture impermeable material.

18. The MDI of claim 17, and further comprising a  
desiccant placed inside of said overwrap.

19. The MDI of claim 18, wherein said desiccant is a  
silica gel.

20. The MDI of claim 17, wherein said overwrap  
comprises a metallic foil.

21. The MDI of claim 17, wherein said propellant is  
HFA-134a, HFA-227 or a mixture thereof.

22. An article of manufacture comprising:

an aerosol dispensing apparatus for dispensing  
metered amounts of fluid material from a reservoir, the  
apparatus comprising a container defining a reservoir, and a  
5 dispensing valve;

a drug formulation located within said aerosol  
dispensing apparatus comprising a safe and effective  
medicament and a pharmaceutically acceptable propellant; and

a flexible package for wrapping and sealing said  
10 container providing an enclosed volume in which said  
pressurized container is disposed, said flexible package  
being impermeable to water vapor and permeable to said  
propellant, said flexible package substantially preventing  
ingression of water vapor and particulate matter into said  
15 enclosed volume while permitting egression of said  
propellant.

23. The article of manufacture of claim 22, further  
comprising a brochure disclosing product information.

24. The article of manufacture of claim 22, further  
comprising a container for enclosing said flexible package.

25. A method of improving a product performance  
comprising the steps of:

providing a flexible package material made of at least  
one heat sealable layer, at least one layer of a metal foil,  
5 and a protective layer; said flexible package material being  
impermeable to water vapor and permeable to a propellant;

filling a container with a drug formulation comprising a  
drug and said propellant at a predetermined pressure;

wrapping said container with said flexible package  
10 material to form an enclosed volume in which said container  
is disposed therein; and

sealing said flexible package which in turn closes said  
enclosed volume, said flexible package substantially  
preventing ingression of water vapor and particulate matter  
15 into said enclosed volume while permitting egression of said  
propellant from said enclosed volume.



26. The method of improving product performance of claim 25, further comprising the step of providing a moisture absorbing material in said enclosed volume.

27. The method of improving product performance of claim 25, wherein said sealing step includes heat sealing said flexible package material.

28. The method of improving product performance of claim 25, further comprising the steps of:

providing a nozzle;

providing a valve; and

5 attaching said nozzle and said valve to said container; said container, valve, and nozzle and valve form an MDI.

29. The method of improving product performance of claim 25, wherein the steps of providing a protective layer and a heat sealable layer include the steps of providing a polyester film and an ionomer film.

30. The method of improving product performance of claim 25, wherein the step of filling said container includes filling the container with a hydrofluoroalkane.

31. The method of improving product performance of claim 30, wherein the step of filling said container includes filling said container with at least one of 1,1,1,2-tetrafluoroethane and 1,1,1,2,3,3,3-heptafluoropropane.

32. A pressurized container storage system, comprising:  
a drug formulation comprising a mixture of a drug and a propellant;

a pressurized container filled with said drug  
5 formulation at a predetermined pressure;

a flexible package for wrapping and sealing said  
pressurized container providing an enclosed volume in which  
said pressurized container is disposed; and

a desiccant in said enclosed volume.

1/3

FIG. 1

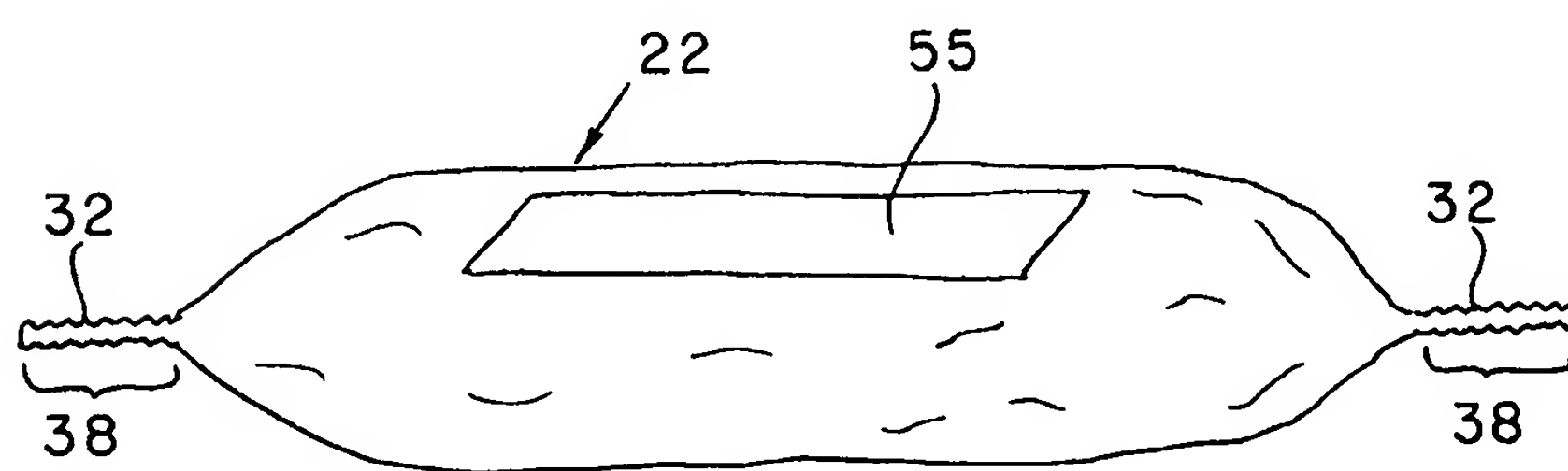
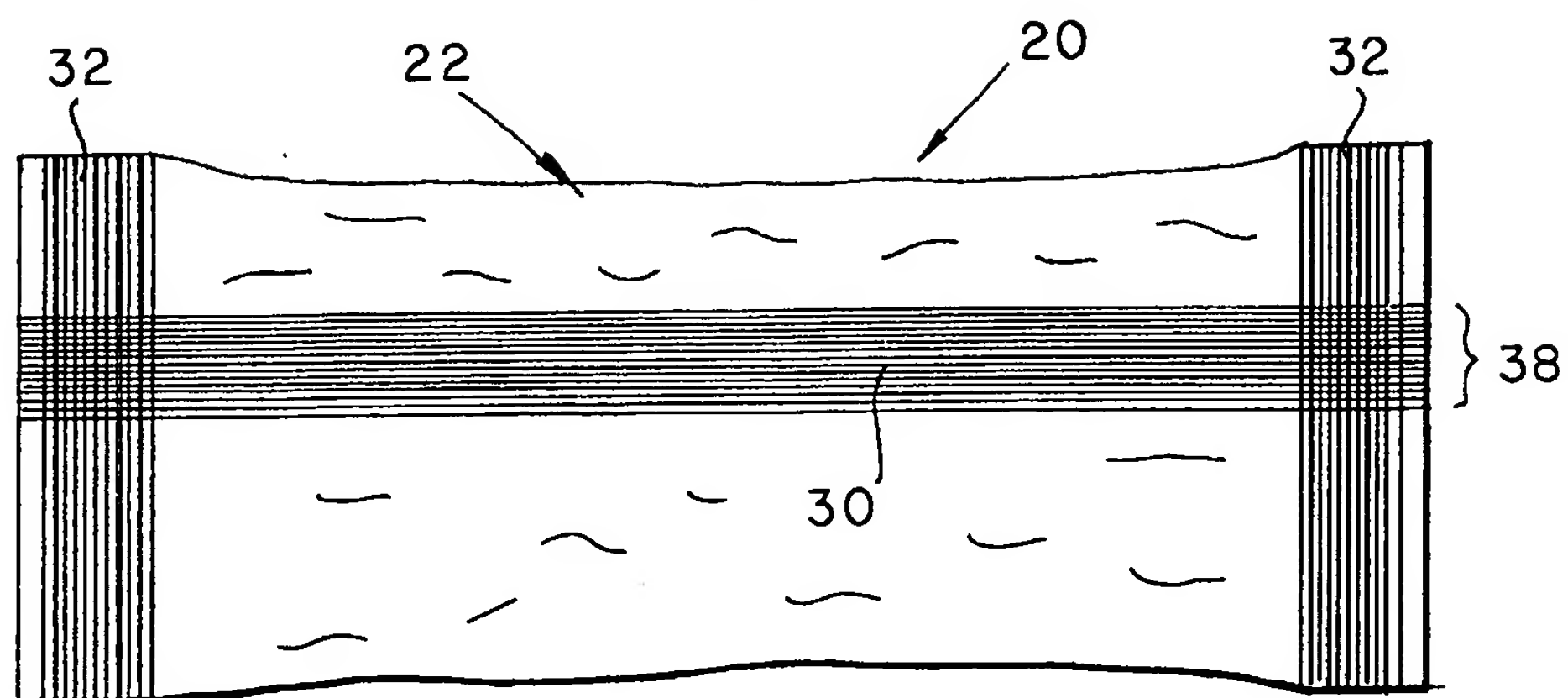


FIG. 2

FIG. 3

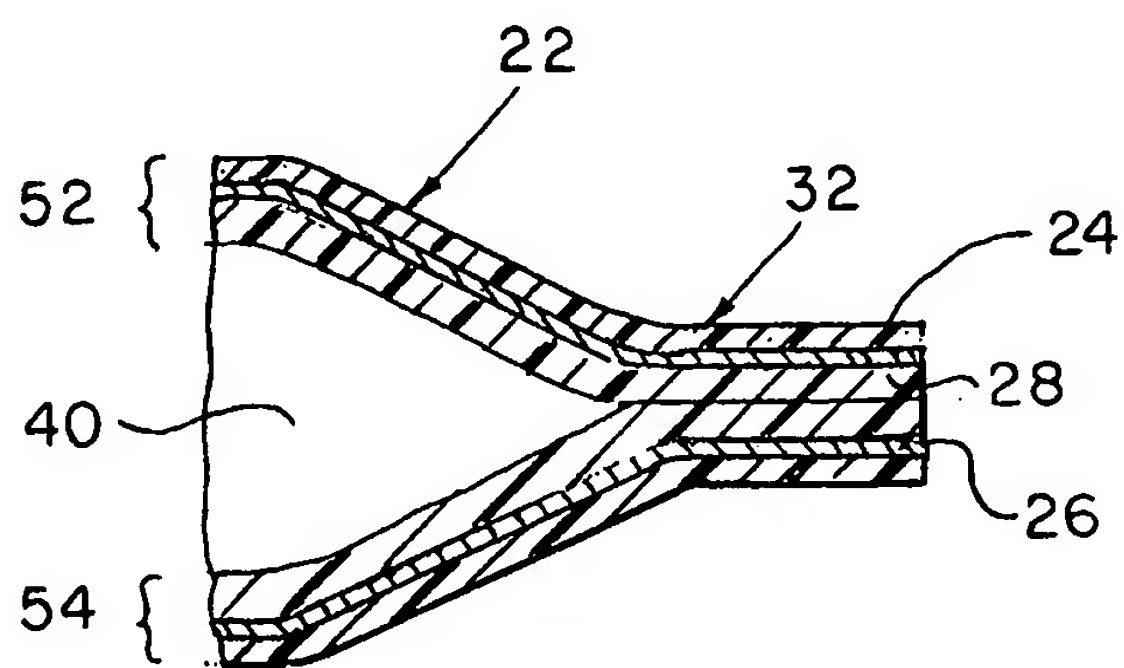
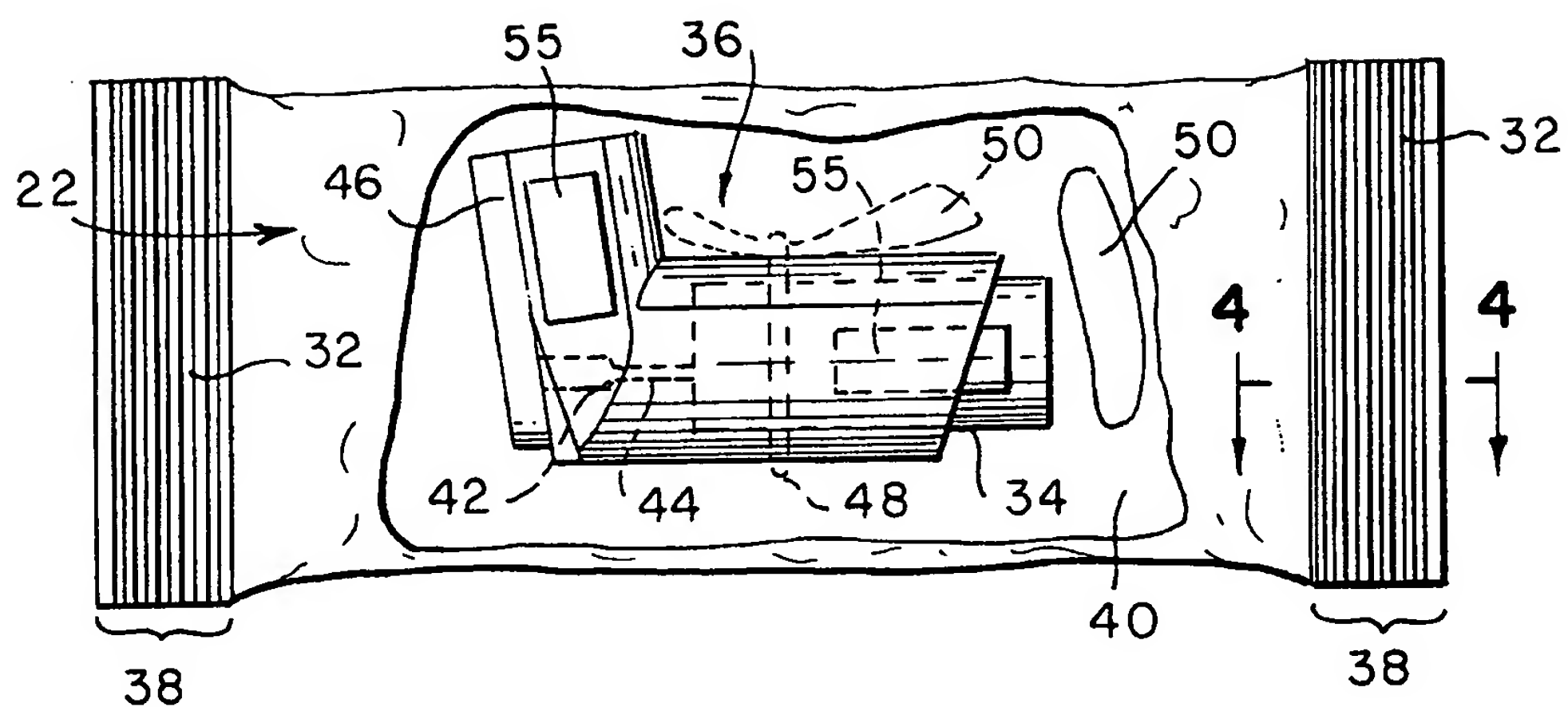


FIG. 4

3/3

FIG. 5

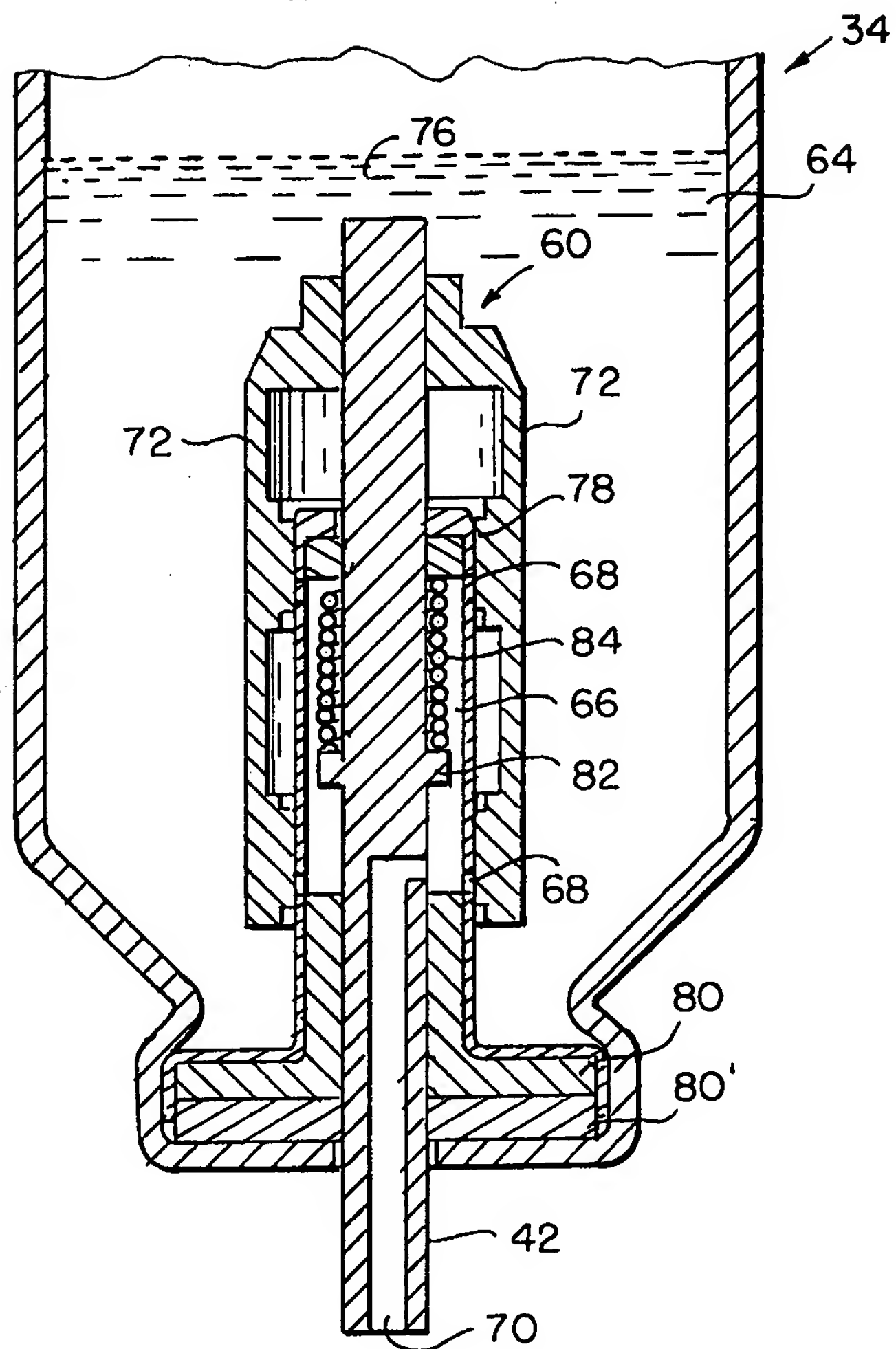
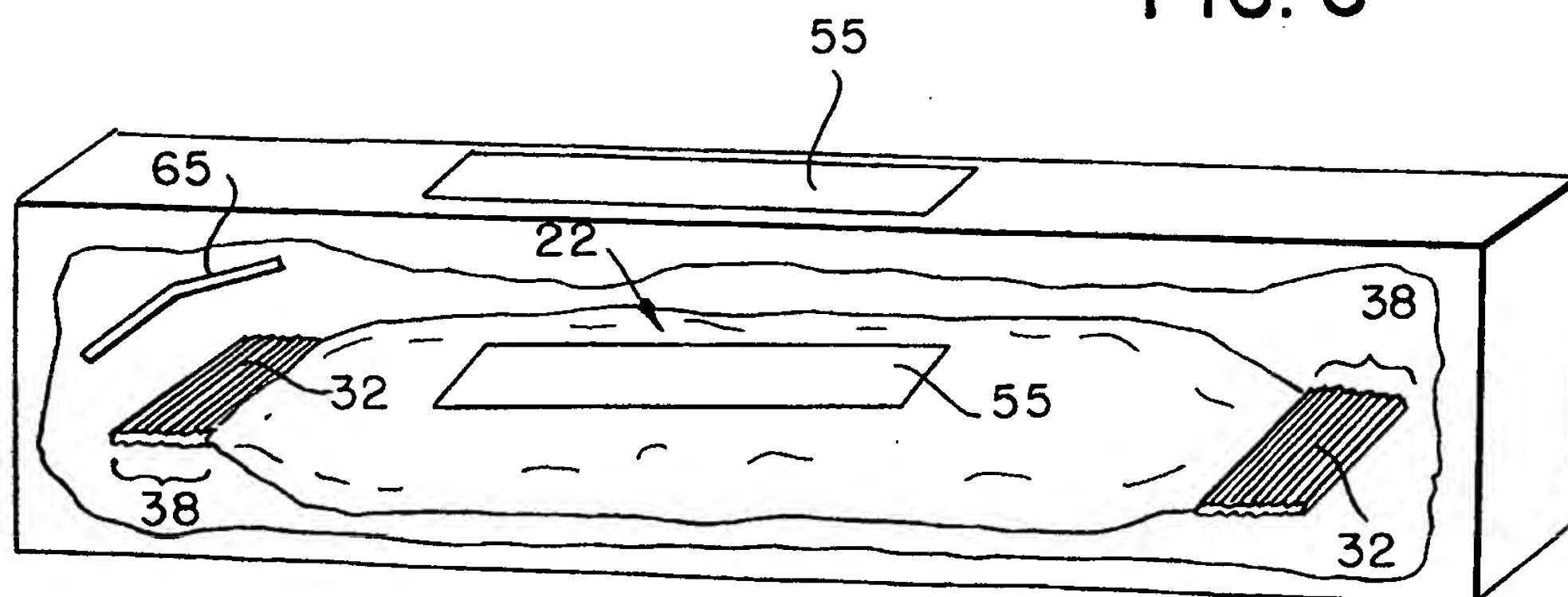


FIG. 6



# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US99/27851

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :B65D 83/00

US CL :206/204, 213.1, 439

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 128/203.15, 203.23; 206/204, 205, 213.1, 363, 438, 439, 484.1, 570

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched  
NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)  
NONE

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4,135,622 A (GLICK) 23 January 1979.	1-32
A	US 4,509,196 A (SAK et al) 02 April 1985.	1-32
A	US 4,655,229 A (SENSABAUGH JR et al) 07 April 1987.	1-32
A	US 4,702,963 A (PHILLIPS et al) 27 October 1987.	1-32
A	US 4,874,090 A (DYKE) 17 October 1989.	1-32
A	US 4,907,394 A (TSCHEPKE et al) 13 March 1990.	1-32
A	US 4,988,558 A (SHIGEMOTO) 29 January 1991.	1-32
A	US 5,073,599 A (GENSKE) 17 December 1991.	1-32



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

05 FEBRUARY 2000

Date of mailing of the international search report

16 FEB 2000

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## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US99/27851

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	US 5,645,051 A (SCHULTZ et al) 08 July 1997.	1-32
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A, P	US 5,746,227 A (ROSE et al) 05 May 1998.	1-32
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A	EP 0,414,536 A (SMITH et al) 27 February 1991.	1-32
A	EP 0,428,380 A (WASS) 22 May 1991.	1-32